GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: May 8, 1979

Project Title: Conduct Investigations into the Use of Acoustic Emission and Scanned Ultrasonics as an Underwater Non-Destructive Testing (NDT) Method for Advanced Diver Equipment

Co-Project No: E-21-E02/E-16-E02 (Sub-project under E-21-E00/Paris/EE)

Project Director: Dr. D. T. Paris/Dr. S. V. Hanagud

Sponsor: Naval Coastal Systems Center; Panama City, FL 32407

Agreement Period: From 4/17/79 (Delivery Order Term) Until ~~4/15/80~~ 12/31/80

Type Agreement: Contract No. N00612-79-C-8004, Delivery Order No. HR-02

Amount:
$25,242 E-21-E02
23,992 E-16-E02
$49,234 Total

Reports Required: Bimonthly Progress Reports; Final Report

Sponsor Contact Person (s):

Technical Matters

Mr. W. W. McCrory
Code 713
Naval Coastal Systems Center
Panama City, FL 32407

Contractual Matters
(thru OCA)

Office of Naval Research
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Georgia Institute of Technology
Atlanta, GA 30332

Defense Priority Rating: DO-S1 under DMS Reg. 1

Assigned to: Electrical Engineering/Aerospace Engineering (School/Laboratory)

COPIES TO:

Project Director
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Project Code (GTRI)
Other _____

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 6/10/82

Project Title: Conduct Investigations into the Use of Acoustic Emission and Scanned Ultrasonics as an Underwater Non-Destructive Testing Method (NDT) for Advanced Diver Equipment

Co- **Project No:** E-21-E02 ~~E-16-E02~~ (subprojects under E-21-E00/Paris/EE)

Project Director: Dr. D. T. Paris/Dr. S. V. Hanagud

Sponsor: Naval Coastal Systems Center; Panama City, FL.

Effective Termination Date: 12/31/80

Clearance of Accounting Charges: 12/31/80

Grant/Contract Closeout Actions Remaining:

- ☐ Final Invoice and Closing Documents
- ☐ Final Fiscal Report
- ☐ Final Report of Inventions
- ☒ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

Assigned to: Electrical Eng./Aerospace Eng. (School/~~Laboratory~~)

COPIES TO: RAM (EE; AE)

~~Administrative Coordinator~~	Research Security Services	EES Public Relations (2)
Research Property Management	~~Reports Coordinator~~ (OCA)	Computer Input
Accounting	Legal Services (OCA)	Project File
Procurement/EES Supply Services	Library	Other _____

FORM OCA 10:781

TASK HR-02: Conduct Investigations into the Use of Acoustic Emission and Scanned Ultrasonics as an Underwater Non-Destructive Testing (NDT) Method for Advanced Diver Equipment.

A. SUMMARY STATEMENT OF WORK COMPLETED DURING THE PAST TWO MONTHS.

This is the first progress report on the Naval Coastal Systems Center Research contract N00612-79-C-8004 under delivery order number HR-02 dated April 17, 1979. The work on this delivery order was initiated on April 17, 1979. This progress report summarizes the investigations during the period April 17, 1979 to June 5, 1979.

B. WORK SCHEDULE STATUS.

One of the goals of this research effort is to develop laboratory experiments to demonstrate the feasibility of using acoustic emission techniques as an under water inspection method. This demonstration requires the design of the test articles, instrumentation system and procedures for testing, recording and interpreting the results. As a first step, the conceptual design of the test articles has been initiated. Basically, two types of designs are being evaluated. One of the designs represents a stiffened plate like structure under bending. The second design consists of a pressure vessel structure. The evaluations are on the basis of (a) simplicity in design, (b) reasonable representation of a practical structure, (c) practical aspects of machining, (d) fabrication problems and (e) cost. The preliminary evaluations have been discussed with the technical monitor.

The second part of the demonstration requires the completion of the instrumentation system for acoustic emission. The following additional equipment would be very useful in acquiring a good demonstration capability.

These are the external memory, the digital interface and the amplitude analyzer. Orders have been placed with the Dunnegan-Endevco Corporation to supply this equipment. The Georgia Institute of Technology is funding the acquisition of the equipment that will be used in this and other projects in progress.

C. BRIEF STATEMENT OF PLANNED WORK FOR THE NEXT TWO MONTHS.

A meeting has been arranged with Dr. Ranson of the University of South Carolina, Mr. McCrory of Naval Coastal Systems Center for purposes of discussion of the different conceptual designs of the test articles and their evaluation. Tests are being planned to check the accuracy of the digital interface and its capability to reproduce the aquired data. Preliminary tests on evaluation of the acoustic emission sources are being planned. These tests will assist in designing the flaws in the test article.

The meeting with Mr. McCrory and Dr. Ranson will also include the discussion of the facilities available at the Naval Coastal Systems Center for fabrication of the test article.

D. PROBLEM AREAS

None

E. FUNDS EXPENDED

None

Principal Investigator: S. Hanagud
Professor
School of Aero Space Engineering

TASK HR-02: CONDUCT INVESTIGATIONS INTO THE USE OF ACOUSTIC EMISSION AND SCANNED ULTRASONICS AS AN UNDERWATER NON-DESTRUCTIVE TESTING (NDT) METHOD FOR ADVANCED DIVER EQUIPMENT

A. Summary Statement of Work Completed During the Past Two Months

During this reporting period, a project meeting was held in an NCSC Office in Panama City Florida. Dr. Hanagud, Dr. Ranson, Dr. Shaw and Mr. McCrory attended the meeting. The following items were discussed at the meeting:

1) Proposed test vehicles for demonstration of the application of acoustic emission technique to the underwater hull inspection,

2) Conceptual design of the diver hand held tool; and

3) The role and the needed developments in the acoustic speckle technique.

It was decided that a plate like structure be initially selected as the test vehicle for the demonstration of the application of acoustic emission technique. The key items to be demonstrated are: (a) the feasibility of determining and measuring acoustic emission in a noisy environment; and, (b) the capability to detect a flaw by acoustic emission technique in a given area.

B. Work Schedule Status

At present, experiments are being conducted at Georgia Tech to demonostrate item (a). The experiment consisted of the detection of acoustic emission in a given area of steel plate. The steel plate is subjected to certain impact and other types of loads to stimulate the noise. The arrangement of the array of transducers, their type, and the needed gains are being designed. Preliminary work has also been initiated for the development of techniques to introduce a controlled crack in the steel plate.

During the meeting, the conceptual design of the diver hand held tool was discussed. It was decided that the present design should be patented. Dr.

Hanagud and Dr. Ranson will prepare the details for further discussion of the patent application with Dr. Shaw and Mr. McCrory. At present a list of the needed equipment for the feasibility demonstration item Ia is being prepared. Any items that need to be purchased will be discussed at the next project meeting with Mr. McCrory. The preliminary list is as follows:

Dunnegan Endevco 9202 Transducer, and the plug in filters

A digital interface

Additional D. E. 9202 Data Processor

Micro Miniature Transducers

C. Brief Statement of Planned Work for the Next Two Months

Further investigations and design of demonstration test (item 1a).

D. Problem Areas

None.

E. Funds Expended

To Date:	$5,681
This Two Month Period:	5,681
Funds Remaining:	43,553
Percent of Funds Expended:	12%
Percent of Task Completed:	15%

Principal Investigator: S. V. Hanagud
Professor
School of Aerospace Engineering

TASK HR-02: CONDUCT INVESTIGATIONS INTO THE USE OF ACOUSTIC EMISSION AND SCANNED ULTRASONICS AS AN UNDERWATER NON-DESTRUCTIVE TESTING (NDT) METHOD FOR ADVANCED DIVER EQUIPMENT

A. Summary Statement of Work Completed During the Past Two Months

The test specimens have been designed by using ASTM-A36 steel in the form of plates of thickness 3/16". A flawed and an unflawed specimen of the same size (12" x 18") have been prepared. The flawed specimen contains a line of surface changes. Two particular studies have been undertaken by using these specimens. The first problem is that of noise rejection by use of frequency filtering techniques, spatial discrimination techniques and techniques concerning the adjustments on gain. The results of the tests conducted during this contract period have shown that acoustic emission signals originiating outside the selected region of the test specimen, and noise characterized by sudden impact, can be eliminated. The spatial filtering system uses a combination of a guardtransducer and a peaked data transducer with optimin resonance characteristics in the frequency range 325 KHz to 650 KHz.

B. Work Schedule Status

Preliminary tests on the feasibility of detections of flaws in the test specimen have been conducted. An alternating concentrated load applied to a selected regions of the plate has been used to stimulate acoustic emissions. Preliminary tests indicate that count per event analysis may offer a promising technique of detection of flaws.

Two project meetings were held in Panama City during this project period. The progress was discussed with Mr. McCrory and Mr. Ranson.

C. Brief Statement of Planned Work for the Next Two Months

The work planned for the next contract period includes the following:

1) Methods of improving rejection of undesirable signals and noise,

2) Improvement of procedures for loading the test specimen,

3) Improvement of transducer location and mounting procedures, and

4) Development of procedures for preparing specimens with flaws.

A preliminary draft of a technical summary report has been directly sent to Mr. McCrory.

D. Problem Areas

Some difficulty was encountered in completely eliminating rubbing or scraping noise from regions very close to the test region. A signature analysis is being considered for rejecting the noise.

The second difficulty was the malfunctioning of the linear locator and the Dunnegon Endevco System 420. The complete system is being checked by the Dunnegan Endevco Corporation at their facilities in California.

E. Funds Expended

To Date: $10,140.79

This Two Month Period: $6,840.54

Funds Remaining: $13,851.21

Percent of Funds Expended: 42%

Percent of Task Completed: 42%

Principal Investigator: S. V. Hanagud

Professor

School of Aerospace Engineering

NAVAL COASTAL SYSTEMS CENTER
OMNIBUS R&D PROGRAM
CONTRACT NO. N00612-79-C-8004

Bimonthly Status Report

Order Number: HR- 2 Title: Investigations Into the use of Acoustic Emission and Scanned Ultrasonics for an Underwater N. D. I. Tool

Task Leader: S. Hanagud

Institution: Georgia Tech

A. SUMMARY STATEMENT OF WORK COMPLETED DURING THE PAST TWO MONTHS

1. The complete system, including the amplitude analyzer and the spatial filter for a selected region of a plate, has been tested. The operation has been found to be satisfactory. The major problem areas with the instrumentation system has been eliminated.

2. The design of the demonstration test has been resumed.

B. WORK SCHEDULE STATUS

The design of the demonstration test.

C. BRIEF STATEMENT OF PLANNED WORK FOR THE NEXT TWO MONTHS

It is proposed to complete the simple demonstration test for flaw detection.

D. PROBLEM AREAS

Because of the delays caused by (a) the nonavailability of NCSC design engineer and (b) the needed repairs of the instrumentation system, a no cost extention of four months has been requested.

E. FUNDS EXPENDED

To Date:	$18,880
This Two Month Period:	2,689
Funds Remaining:	5,112
Percent of Funds Expended:	78%
Percent of Task Completed:	70%

NAVAL COASTAL SYSTEMS CENTER
OMNIBUS R&D PROGRAM
CONTRACT NO. N00612-79-C-8004

Bimonthly Status Report

Order Number: HR- 2 Title: Investigation of the use of Acoustic Emmission and Scanner Ultra Sonics for an Under Water N. D. I. Tool.

Task Leader: S. Hanagud

Institution: Georgia Tech

A. SUMMARY STATEMENT OF WORK COMPLETED DURING THE PAST TWO MONTHS

1. The Data Acquistion system has been checked and calibrated. The accuracy of the detected counts, events and amplitude has been established.

2. Preliminary work on the signal analysis has been initated.

3. The test design has been discussed with Dr. Ranson and Mr. Dimartino.

4. A Project meeting was held at Georgia Tech to discuss the progress. Dr. Ranson, Mr. Dimartino, and Dr. Hanagud participated in the meeting. New Guide Lines were established.

B. WORK SCHEDULE STATUS

1. Coordination of the test design with Dr. Ranson.
2. Acoustic Emission tests on steel specimens.

C. BRIEF STATEMENT OF PLANNED WORK FOR THE NEXT TWO MONTHS

1. Coordination of the test Design with Dr. Ranson.
2. Incorporation of the New Guide Lines established at the project meeting.

D. PROBLEM AREAS

NONE

E. FUNDS EXPENDED

To Date:	$19,925
This Two Month Period:	11,632
Funds Remaining:	4,067
Percent of Funds Expended:	83%
Percent of Task Completed:	75%

NAVAL COASTAL SYSTEMS CENTER
OMNIBUS R&D PROGRAM
CONTRACT NO. N00612-79-C-8004

Bimonthly Status Report

Order Number: HR-2 Title: Investigation into the use of Acoustic Emission and Scanned Ultransonics for an Underwater N.D.I. tool.

Task Leader: S. Hanagud

Institution: Georgia Institute of Technology

A. SUMMARY STATEMENT OF WORK COMPLETED DURING THE PAST TWO MONTHS

1. The task of designing a demonstration test has been resumed. The demonstration test uses a steel plate as the test vehicle. The plates with and without cracks have been used. A spatial filtering has been designed under the known guidelines of their limitations and capabilities. These guidelines have been developed at Georgia Institute of Technology. Some tests have been conducted by using repeated load. Impact load tests are in progress.

2. Preliminary tests have been conducted to develop techniques of direct signal analysis of acoustic emission. These techniques are needed to improve the reliability of acoustic emission technique. The improvements are sought in the fields of (a) spatial filtering operations and (b) N.D.I. information on cracks and other defects.

The direct signal analysis is being investigated by the use of Biomation 8100 A/D converter and additional software package.

Such an improvement in reliability combined with the fast speed and cost benefits offered by acoustic emission should make the developed technique a very valuable N.D.I. tool.

B. WORK SCHEDULE STATUS

1. Completion of demonstration test

2. Preliminary tests on direct signal analysis

C. BRIEF STATEMENT OF PLANNED WORK FOR THE NEXT TWO MONTHS

1. Demonstration tests

2. Direct signal analysis

3. Documentation

D. PROBLEM AREAS

The NCSC design engineer has not been available during the project. After discussions with project engineer Mr. Dimartino, the tasks have been rearranged for completion during the project period.

E. FUNDS EXPENDED

To Date:	$20,022.00
This Two Month Period:	97.00
Funds Remaining:	3,970.00
Percent of Funds Expended:	84%
Percent of Task Completed:	85%